

Protective Measures Evaluation Summary

Protective Measure Category/Protective Measure Example	Description	0.2-Acre Residential				2-Acre Residential				20-Acre Pre-development			
		Human Health Effectiveness (1)	Ecological Effectiveness (1)	Cost (2)	Practicality (3)	Human Health Effectiveness (1)	Ecological Effectiveness (1)	Cost (2)	Practicality (3)	Human Health Effectiveness (1)	Ecological Effectiveness (1)	Cost (2)	Practicality (3)
Consultant Team Suggested Rankings													
Education Programs	Education programs refer to broad-based, community-wide efforts to inform individuals and businesses of the presence of contamination and changes in behavior that can be taken to limit or reduce exposure to the contamination. Such programs use a wide range of techniques to distribute information and increase public awareness. Application of education programs to pre-developed properties refers to educating residents living near the pre-developed property. Often implemented in conjunction with other protective measures, such as physical barriers.												
Public Meetings	Used to disseminate information on the presence of contamination, the status and progress of cleanup efforts, and steps that can be taken to limit or reduce exposure to the contamination. Typically funded through local and state governments.	●○○○	○○○○	●●●○	●●●○	●○○○	○○○○	●●●○	●●●○	●○○○	○○○○	●●●○	●●●○
Brochures/Fact Sheets/ Newsletters/Videos/Recordings/ Websites	Used to disseminate information on the presence of contamination, the status and progress of cleanup efforts, and steps that can be taken to limit or reduce exposure to the contamination. Typically funded through local and state governments.	●○○○	○○○○	●●●○	●●●●	●○○○	○○○○	●●●○	●●●●	●○○○	○○○○	●●●○	●●●●
School-Based Programs	Provide education programs within the K-12 system, including school newsletters, classes on environmental issues in the community, and instruction on the importance of following BMPs or other protective measures. Typically funded by local schools with grant money available through local or state governments in some cases.	●○○○	○○○○	●●●○	●●●○	●○○○	○○○○	●●●○	●●●○	●○○○	○○○○	●●●○	●●●○
Post No-Trespassing Signs	Post No-Trespassing or other informational signs at perimeter of contaminated area. Paid for by landowner.	NA	○○○○	●●●○	●○○○	NA	○○○○	●●●○	●○○○	●○○○	○○○○	●●●●	●●●●

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Consultant Team Suggested Rankings													
Land Use/Institutional Controls	Actions by government or private agreements to limit or prohibit activities that could result in exposure to contaminants or harm a physical barrier or other engineered control. Also includes site-specific actions to increase knowledge of contamination, such as disclosure approaches. Often implemented in conjunction with other protective measures, such as physical barriers.												
Zoning	Governmental limits on land use that could lead to exposure to contamination. Enacted, enforced, and typically funded by local governments in accordance with state statutes. Estimated costs do not include loss-of-use costs by property owners.	●●○○	○○○○	●●●●	●●○○	●●○○	○○○○	●●●●	●●○○	●●●●	○○○○	●●●●	●●○○
Permits and licenses	Enhanced governmental review of projects that could lead to exposure to contamination can be required for variety of activities from any level of government (local, state, federal). Typically funded by the level of government issuing the permit or license. Estimated costs do not include property owners' costs for obtaining permits/licenses or loss-of-use.	●●○○	○○○○	●●●●	●●○○	●●○○	○○○○	●●●●	●●○○	●●●●	○○○○	●●●●	●●○○
Covenants, conditions and restrictions	Proprietary controls voluntarily placed on a deed by a property owner. Generally apply to a single piece of property, or property being subdivided, and may have a specific life-span, often ten years. Typically funded by private parties. Estimated costs do not include loss-of-use costs by property owner.	●○○○	○○○○	●●●●	●●○○	●○○○	○○○○	●●●●	●●○○	●○○○	○○○○	●●●●	●●○○
Easements	Proprietary controls that may be voluntarily placed by a property owner or required by government (e.g. easements for roads are required). May cover a wide variety of activities or use limitaions. Generally last forever.	●○○○	○○○○	●●●●	●●○○	●○○○	○○○○	●●●●	●●○○	●○○○	○○○○	●●●●	●●○○
Deed and plat notices	Informational devices, not a limit on use. Applied to individual parcels of land or, for plat notices, to an entire plat. Typically, costs incurred by party establishing deed or plat notice and by level of government that records them.	●○○○	○○○○	●●●●	●●○○	●○○○	○○○○	●●●●	●●○○	●○○○	○○○○	●●●●	●●○○
Real estate disclosure forms and practices	Information provided to potential purchasers as part of real estate transactions (e.g. areawide environmental disclosure).	●○○○	○○○○	●●●●	●●○○	●○○○	○○○○	●●●●	●●○○	●○○○	○○○○	●●●●	●●○○
Public Health Programs	These programs generally involve activities designed to identify and focus protective measures on specific populations within a community considered to be at high risk. Application of public health programs to pre-development properties refers to providing these programs to residents living near the pre-development property.												
Health Monitoring	Health monitoring includes measuring blood lead levels in children and arsenic levels in hair and urine and providing test results and written material on appropriate actions to reduce exposure. Typically funded through local and state governments.	●○○○	○○○○	●●●●	●●○○	●○○○	○○○○	●●●●	●●○○	●○○○	○○○○	●●●●	●●○○
Home Visits/One-On-One Education	Trained professionals perform routine visits at high risk residences to evaluate and address sources contributing to elevated exposures and to provide individual instruction on measures to reduce exposure. Typically funded through local and state governments.	●●○○	○○○○	●●●●	●●○○	●●○○	○○○○	●●●●	●●○○	●●○○	○○○○	●●●●	●●○○
Intervention Activities	Responses to a finding of elevated blood lead levels or urinary arsenic levels may include 1) referral to physician, 2) source investigations and/or implementation of appropriate intervention activities	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)

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Consultant Team Suggested Rankings															
Best Management Practices	Best management practices (BMPs) are simple day-to-day activities that students, teachers, residents, and employees can follow to limit or reduce exposure to soil contaminants in certain circumstances. Best management practices (BMPs) could involve implementation of actions suggested through educational or public health programs. Property owners or residents typically provide all labor and/or money to implement BMPs, which are usually low cost items.														
Practice Personal Hygiene	Wash hands and face thoroughly after working or playing in the soil, especially before eating. No eating or smoking while doing tasks in potentially contaminated areas.	●○○○	○○○○	●●●●	●●○○	●○○○	○○○○	●●●●	●●○○	NA	NA	NA	NA		
Wash Garden Vegetables and Fruits	Wash or peel garden vegetables and fruits carefully to remove all soil particles.	●●○○	○○○○	●●●●	●●●●	●●○○	○○○○	●●●●	●●●●	NA	NA	NA	NA		
Remove Shoes Before Entering Home	Remove work and play shoes before going inside after working or playing in or walking on contaminated soil.	●○○○	○○○○	●●●●	●●●●	●○○○	○○○○	●●●●	●●●●	NA	NA	NA	NA		
Damp-mop and Dust or Vacuum with a HEPA Vacuum	Damp-mop and dust floors and counters frequently. Vacuum floors and upholstery frequently using a vacuum with a HEPA filter.	●●○○	○○○○	●●○○	●●○○	●●○○	○○○○	●●○○	●●○○	NA	NA	NA	NA		
Moisten Soil to Minimize Dust	Wet down soil while gardening or digging to limit the amount of dust inhaled.	●○○○	○○○○	●●●●	●●●●	●○○○	○○○○	●●●●	●●●●	NA	NA	NA	NA		
Wear Protective Clothing	Wear coveralls and hat while working in soil. Remove work clothes at completion of task and launder items separately.	●○○○	○○○○	●●●●	●●●●	●○○○	○○○○	●●●●	●●●●	NA	NA	NA	NA		
Request Soil Test Results	Owner or resident requests and obtains soil test results from government agency to learn about contamination levels at residential or nearby properties. Soil testing on large pre-developed lots would most likely be paid for by the property owner.	●○○○	○○○○	●●●●	●●●●	●○○○	○○○○	●●●●	●●●●	●○○○	○○○○	●●●●	●●●●		
Garden Using Raised Beds	Garden within clean soil to minimize exposure while gardening and potential ingestion of contaminants on or in food crops.	●●○○	○○○○	●●●●	●●●●	●●○○	○○○○	●●●●	●●●●	NA	NA	NA	NA		

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		Consultant Team Suggested Rankings											
Physical Barriers	Physical barriers prevent or limit unauthorized access to property or exposure to contaminated soil. May be used in combination with excavation to consolidate contaminated soil in a containment zone, especially at pre-developed properties or areas with frequent exposure. Funding for physical barriers may be provided by the landowner, local or state governments, or by the identified responsible party.												
Fencing	Construct fencing to control access to the property.	●○○○	○○○○	●○○○	●●○○	●○○○	○○○○	●○○○	●●○○	●○○○	○○○○	●●●●	●●○○
Vegetative Cover	Establish and maintain a vegetated surface on top of exposed soil to reduce dust and direct exposure to soil.	●●●○	○○○○	●●○○	●●●○	●●●○	○○○○	●○○○	●●●○	●●●○	○○○○	●●●●	●●○○
Wood Chip Cover	Cover exposed soil with a geotextile fabric and several inches of wood chips to reduce dust and direct exposure to soil.	●●●○	●●○○	●○○○	●●●○	●●●○	●●○○	●○○○	●●○○	●●●○	●●○○	●●●○	●●○○
Clean Soil Cover	Place a geotextile fabric directly on top of exposed soil followed by 6 or more inches of clean soil. Establish and maintain a vegetated surface on top of soil to minimize erosion.	●●●○	●●○○	●○○○	●●○○	●●●○	●●○○	○○○○	●●○○	●●●○	●●○○	●●●○	●●○○
Pavement Cover	Place concrete pavers or an asphalt pavement cover over exposed soil to reduce dust and direct exposure to soil.	●●●○	●●●○	●○○○	●○○○	●●●○	●●●○	○○○○	●○○○	●●●○	●●●○	●●○○	●●○○
Reducing Contamination	Actions to reduce the concentration of contaminants in soil or to remove the contamination for disposal at another location or in a containment zone. Funding for reducing contamination may be provided by the landowner, local or state governments, or by the identified responsible party.												
Soil Blending/Tilling	Mix near-surface soil containing arsenic and/or lead with cleaner soil at depth to reduce the concentration of contaminants in the newly formed surface soil.	●●●●	●●●●	●○○○	●●○○	●●●●	●●●●	○○○○	●●○○	●●●●	●●●●	●●○○	●●○○
Soil Removal and replacement	Excavate soil containing arsenic and/or lead and replace this soil with clean fill. Establish and maintain a vegetated surface on top of fill to minimize erosion of the fill. Dispose of contaminated soil at another location.	●●●●	●●●●	●○○○	●●○○	●●●●	●●●●	○○○○	●●○○	●●●●	●●●●	●●○○	●●○○
Phytoremediation	Establish and maintain sufficient plant growth on contaminated soil to promote the uptake of arsenic and lead from the soil into the aboveground portion of the plant. Harvest and dispose of the plants and then repeat process until desired concentrations are obtained.	●●○○	●●○○	●○○○	●○○○	●●○○	●●○○	○○○○	●○○○	●●○○	●●○○	●●○○	●○○○

Protective Measures Evaluation Summary Footnotes

NA = Not Applicable

(1) Human health effectiveness for the institutional protective measure categories of Education Programs, Land Use/Institutional Controls, and Public Health Programs is based on the level of participation these measures attract and the ability of these programs to influence participants to change behaviors or implement recommended actions to reduce exposure to contamination. Education Programs, Land Use/Institutional Controls, and Public Health Programs protect people but not ecological receptors such as birds, rodents, and reptiles. Human health effectiveness for the physical protective measure categories of BMPs, Physical Barriers, and Reducing Contamination is based on the ability of these physical protective measures to reduce exposure to contamination. Ecological effectiveness is based on the ability of the protective measure to reduce exposure to terrestrial plants, invertebrates, and wildlife. Effectiveness ratings are based on the following scale:

- = No Effect
- = Minimal Effect
- = Some Effect
- = Effective
- = Very Effective

(2) Cost for the two residential scenarios is based on applying the protective measure to the entire population described in the residential scenario (i.e. 4,000 properties, 10,000 residents). Accessible contaminated soil is assumed to be present at a depth of 0.5 to 1.5 ft over one-half of the 0.2-ac property and 90 percent of the 2-ac property. Cost for the 20-ac pre-development property is based on applying the protective measure to a single 20-ac pre-development property. Accessible contaminated soil is assumed to be present over the entire 20 acres at a depth ranging from 0.5 to 1.5 ft. Costs for application of the pavement cover protective measure to the 20-ac pre-development property assume that contaminated soil is excavated, consolidated to 20 percent of the original property size, and that an asphalt pavement cover is placed over the soil. A 30-year project life is assumed for protective measures with recurring annual costs (e.g. Education Programs, Public Health Programs). Cost ratings are based on the following scale:

- = over \$200,000,000
- = \$20,000,000 to \$200,000,000
- = \$2,000,000 to \$20,000,000
- = \$200,000 to \$2,000,000
- = \$0 to \$200,000

(3) Practicality is a measure of the technical, social, and administrative barriers to implementing the measure. For example, there are few social or technical barriers to holding public meetings or sending brochures, but excavating all the soil from yards on small, developed residential lots is technically challenging and socially disruptive. Practicality does not consider the ability to obtain funding for the measure. Practicality is ranked on the following scale:

- = Not Practical
- = Minimal Practicality
- = Some Practicality
- = Practical
- = Very Practical

(4) See summaries on BMPs, physical barriers, and reducing contamination for descriptions and rankings.